S Y N O P S I S

India stands second among the silk producing countries of the World The silk production process which spans across both the agricultural and industrial sectors, involves a series of operations starting from silkworm seed production, rearing of cocoons using mulberry leaves, reeling of the cocoons into raw silk yarn, twisting of the raw silk yarn, and finally, weaving of the twisted yarn to get the final fabric. In India, these operations are performed in separate independent segments and there is very little vertical integration of the industry Also, all these segments mostly belong to the unorganized sector The states of Karnataka and Andhra Pradesh account for more than 80% of the Indian Silk Production.

Recently, a study of the economics of operations in each of the five segments of the silk industry (seed production, rearing, reeling, twisting and weaving) was undertaken at the Department of Management Studies, Indian Institute of Science, as part of a research project sponsored by the Central Silk Board, Government of India Extensive primary data was collected from the states of Karnataka and Andhra Pradesh through questionnaires and personal interviews from 312 silkworm rearers, 163 cocoon reelers, 28 licensed seed producers, 13 twisters and 34 weavers From the results of this project, it was observed that specifically the silk yarn reeling sector is the one which is economically unsound and subject to the vagaries of the market This is also endorsed by the publications of the Central Silk Board, in which it is observed that the reeling segment gets only 6 8 percent of the overall share in the price paid by the consumer for the ultimate silk fabric It was found that in the reeling sector large sums of working capital is required for the day to day operations and that working capital accounts for more than 90% of the cost of the silk yarn The study also indicated that there was considerable variation in the financial performance as a result of uncertainties prevailing in the production parameters in the reeling segment Keeping the above factors in mind, the proposed research

work focusses upon some of the uncertainties and economic issues related to the silk reeling industry

The primary data collected from the 163 reelers (reeling units) as part the sponsored project contained information on (a) individual profiles, (b) production parameters, (c) cost information and d) revenue information Since the size of operation in terms of number of reeling basins (capacity) varied across the reeling units, all the information related to costs and revenue of each reeling unit was converted to a standard "per day per basin' concept After standardising, it was found that data for 6 reelers had spurious information regarding some of the attributes As a result, they were treated as "outliers' and were eliminated from the data set leaving a total of 157 data records for analyses

As a first step in the process of analysing the performance of silk reeling industry, 15 parameters were identified as adequate to study the reeling segment in greater detail The variability and uncertainties associated with these input parameters affecting the financial performance of the silk reeling industry were studied by characterizing them into either standard statistical distributions or empirical distributions using the observed field data A number of attempts were made to see if these parameters could be characterized into certain standard statistical distributions such as Exponential, Gamma, Normal or Log-Normal distributions with adequate statistical support for the goodness of fit From the analysis carried out, it was found that out of the 15 input parameters considered, 11 could be characterized into standard statistical distributions These were validated using tests of goodness of fit The remaining four parameters were characterised as empirical (observed) distributions

A simulation model is developed for studying the effect of uncertainties or changes in these input parameters on the total cost, total revenue and therefore the net profit in reeling operations The statistical distributions

derived from field data were used as the basis for this work. A computer program was written in 'C' language to generate the input random variates from the respective statistical distributions or the empirical distributions identified earlier A set of functional equations were built into the model for computing total cost, total revenue and hence the net revenue for a given set of input parameters Thereby, the profitability of operations of the reeling unit is simulated for each set of generated input variables Using a standard criteria as a stopping rule, the simulation runs were terminated after about 900 runs. Then, the "steady state" and the associated performance measures are obtained It was observed that the net profit for reeling units would vary from a negative Rs 1357/- to a positive Rs 999/- per day per basin The average net revenue was found to be stabilizing at around a negative Rupees 67/- per day per basin This implies that the reelers would lose about Rs 67/- per day per basin on an average, as a result of the variability and uncertainties prevailing in the input parameters Based on the simulation runs, the probability of the reelers getting a positive profit was found to be low at 0 47 Traditional t-tests were carried out and Confidence Intervals were constructed in order to test whether there is any significant difference in the observed and simulated data for all the input parameters This analysis endorses the fact that the reelers, who play a key role in converting the cocoons into raw silk yarn are not getting their due share It may be noted here that reeling is the only segment of the silk industry which has to participate in an open auction market mechanism for both the purchase of its raw material and the sale of its product

Having developed a basic simulation model, the effect of shifts in parameters like (i) renditta (a measure of yield) and (ii) reeler/labour productivity on the profitability were analysed in the stochastic framework so as to bring in the concept of standardization or to get some benchmarks which could result in sustained profitability The renditta was varied from 8 Kg of cocoons per Kg of

silk to 12 Kg while the labour productivity was varied from 0 8 Kg of silk yarn per basin per day to 1 8 Kg. The use of the simulation model in the framework of 'What if' scenario analysis resulted in the following observation Other things being held equal, either (i) there has to be a downward shift in the average value of the renditta to get better profitability, with a maximum value of about 9 6 for break-even or (ii) there has to be an upward shift in the average value of productivity (minimum of about 1.32 Kg of silk yarn per basin per day), so that reeling becomes profitable in the cottage industry sector. As a step forward, the task of integrating the technical quality characteristics of the cocoons as evaluated in the laboratories of the research institutes with the parameters of the simulation model was attempted The Central Silk Technological Research Institute, Bangalore, carries out routine tests on cocoon quality characteristics and the silk yarn reeling characteristics for random samples from different places Some of the parameters generally analysed in these laboratory tests are Shell Ratio, Renditta, Filament Denier, Average Filament Length, Waste Percentage on Silk Weight, Defective Cocoon Percentage, Average Non-Breakable Filament Length and Raw Silk Recovery Using these secondary data, it was decided to explore whether any statistical relation exists between renditta and the other technical quality characteristics It was observed through a stepwise regression model, that five of these cocoon quality parameters namely, Waste Percentage on Silk Weight, Average Non-breakable Filament Length, Shell Ratio, Defective Cocoon Percentage and Filament Denier are adequate to predict the renditta with a fair degree of accuracy These identified cocoon quality characteristics were then embedded into the simulation model as input variables Using the estimated renditta and the steady state values of the parameters, the resultant net revenue was estimated using a spread sheet software. This analysis, which is exploratory in nature, provides useful insights regarding the effect of changes in cocoon quality characteristics on the profitability in reeling Further, sensitivity analyses was performed by changing one cocoon quality parameter at a time and keeping the

other four constant to get an insight on the marginal effect of changes in these quality parameters on the profitability in silk reeling

As observed earlier, the reeling units require huge amounts of working capital for buying the cocoons (raw material) and holding inventories of cocoons and silk yarn The amount of working capital also depends on the size of the reeling units, the frequency of visits to the cocoon markets for buying and the frequency of visits to the silk (yarn) exchange for selling As a result, interest costs on working capital could play a prominent role in determining the profitability of reeling operations To analyse its effect, an Operations Research approach was considered with the following questions Suppose, there is a certain amount of working capital available with a reeling unit at a specific interest rate, what would be the optimal revenue that can be obtained during a specific planning horizon? How does the net profitability vary, with changes in the availability of working capital and interest rates? What is the ideal working capital that is needed for a reeling unit so that it could perform optimally in its buying, selling and inventory strategies ? To answer some of these decision problems typically faced by the reeling units, a Linear Programming model was developed. The results obtained by the use of this Linear Programming model provide insight on how the net profitability and working capital requirements vary for different combinations of renditta and labour productivity

This study focuses mainly on analysing uncertainties and profitability of operations in the silk reeling industry It is believed that the results of the study would help the Central and the State Governments in policy formulations as well as the silk reeling entrepreneurs in operational planning decisions